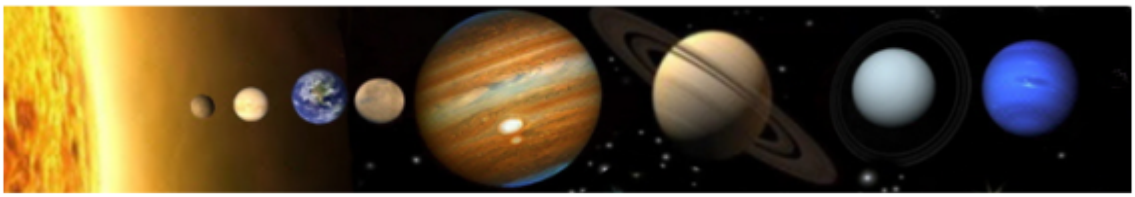
Astronomy 202 / Physics & Astronomy Department

Exploration of the Solar System

Syllabus



Instructor:	Eugene H. Levy
Physical Location:	318 Herman Brown Hall; 713-348-4121
Virtual Addresses:	Email: ehl@rice.edu | Home Page: http://ehl.web.rice.edu
Class Websites:	CANVAS & Link from http://ehl.web.rice.edu

The course is intended to satisfy Group III distribution requirements. Students seeking to accumulate credits toward fulfilling a major in astronomy/astrophysics should consider courses such as ASTR 350/Introduction to Astrophysics-Stars or 470/Solar System Physics, which provide credit toward the major degree. On the other hand, this could be a good place to start, and prospective majors are welcome too.

Space Science & Technology (SST) Building / Room 106 / Tue & Thu 9:25 - 10:40 am
Class Office Hours: Thursday after class until noon, or flexible by appointment

Course Objectives

We humans are a cosmic phenomenon, having emerged as a result of the processes that shaped the Universe since its apparent start in the so-called Big Bang some 13.8 billion years ago. Up close, we are a planetary phenomenon. We originated on, and inhabit, a small, rocky, damp planet, orbiting -- along with a handful of other planets -- an otherwise undistinguished star, the Sun. The Sun is located in an otherwise undistinguished region of a galaxy, the Milky Way, containing more than 100 billion other stars, some brighter than the Sun, some dimmer, some older, some younger. The part of the universe within our view contains an estimated 100 billion other galaxies -- some larger than the Milky Way, some smaller. Earth formed along with seven other extant planets (and myriad smaller rock-and-ice objects) around the Sun at about the same time that the Sun itself formed, some 4.5 billion years ago. By that time our universe had already evolved through two-thirds of its current age. Star formation is a continuing process throughout the Universe; we observe it taking place still in our Galaxy and infer its continuity in distant galaxies. Recent evidence supports the long-held assumption that planet formation is also ubiquitous and ongoing.

We call our system of the Sun along with its associated planets, moons, and swarms of orbiting debris, the *Solar System*. So far as we know, the Solar System is not special in the Universe, and occupies no special position. But, in a real sense, this Solar System -- containing *our* planet -- is the center of *our* universe, as good a center as any other place, and singularly important to us.

Evidence indicates that life has been present on Earth throughout most of Earth's existence, probably having developed from geochemical processes between 3.5 and 4 billion years ago. The evidence shows that, during most of the time since, terrestrial life consisted entirely of individual cells: bacteria and other microbes. Only during the most

recent billion years or so have large lifeforms -- multicellular organisms, descended from colonies of those microbes -- become a prominent feature of our planet. The slow, complexifying evolution of terrestrial life was driven by genetic mutations subject to natural selection acting through the interplay of both symbiotic cooperation and competition within and among species. Humans developed relatively recently out of those antecedents, having evolved to our current state gradually over the most recent several million years . . . an interval of time occupying only about a tenth of one percent of our planet's history.

We live at an extraordinary time: After eons of development from single cells to human beings, modern civilization -- supporting vast technologically-based urbanization -- emerged only over the past 10,000 years or so (just about a tenth a percent, again, of the time since protohumans and humans evolved on Earth).

Humans -- along with all species on Earth -- are a product of biological evolution. However, humans, to an extent greater than any other terrestrial species, developed the capacity for cultural evolution, involving the collection, aggregation, organization, synthesis, memorization, recording and transmission of experience among individuals and through generations. The development of modern science, most impressively during the past 500 years, is one of the most stunning consequences of that capacity for cultural evolution. Scientific understanding gives us unprecedented ability to learn about our planet, our solar system, and our universe (and eventually ourselves) in remarkable depth. And it has given us the ability to begin elucidating and understanding the history and processes that produced us and shape the terrestrial and cosmic environment on which our existence and sustenance depend.

This course is concerned mainly with the physical science aspects of our Solar System. We will learn about the physical constitution of the Solar System and its various objects, as well as how they came to be, and how and why they behave as they do. We will study how we learned what we know about the Solar System, starting with the era of telescopes, which has largely given way to the era of exploration. The current era of exploration already stretches over nearly 60 years, as robotic spacecraft have explored Solar System objects up close, and *in situ*, even, in some cases, returning samples to Earth for analysis in laboratories. We will study how and why the various planets in our Solar System differ, and the ways in which they are similar, including in terms of their potential capacities to support life. We will learn how studying other planets has helped us better understand Earth, including the possibilities -- and possible driving mechanisms -- of climate change on Earth. We will look past the current Solar System to learn what we know of its history and development, and how we know it. And we will look beyond our Solar System to see what we are learning about the existence of planetary systems around other stars.

Throughout the semester, we emphasize how the basic forces, motion, and the structure of matter work to shape and control our world, and help us to understand what we see. A full understanding of our own planet, Earth, ultimately requires an appreciation for the central role that life has played -- and still plays -- in shaping it. We will touch on that.

The primary conceptual aims of this course are: 1) to explore how science has revealed the nature of the Solar System -- the immediate environment of humans -- its history and cosmic context, and the processes that shape it; 2) to help you comprehend how the structure and behavior of matter shape the physical world; and 3) to help you gain an appreciation of how we know what we know, and why we are able to be confident in that

knowledge. An ancillary goal of this class is to help expand your understanding of the every-day world around you.

This discovery and understanding that underlie this course are made possible by the fact that our universe appears to be what early Greek philosophers termed to be a *cosmos*:

> *Merriam-Webster Dictionary:*
> **COSMOS** 1. an orderly harmonious systematic universe -- cf. CHAOS

The apparent order, harmony, and systematic nature of our universe is reflected in the fact that it seems to be governed by regular, reliable laws, which, remarkably, are discoverable by human intelligence. Although we, by now, know a great deal, with high certitude, about our world writ large, there is still a great deal that we do not yet know. The focus of this course -- to understand the Solar System (and the universe) -- is an ongoing endeavor.

Prerequisites

No special scientific or mathematical background beyond familiarity with typical high school science and mathematics is assumed or needed for this course. Calculus will not be required, but we will engage some rudimentary equations (algebra) and numerical calculations. These will be designed to reinforce what you learn and help strengthen your skills in applying quantitative reasoning.

One animating motive of this class is to help you learn how much you can understand from relatively easy-to-grasp ideas and concepts.

Learning Outcomes

The specific learning outcomes aimed at in this course include:

- Developing knowledge of basic scientific principles, and of how these principles are employed to advance and secure understanding of our world
- Advancing knowledge of the crucial roles played by observations, experiments and exploration in securing and understanding our world.
- Elucidating how the nature and behaviors of objects and systems throughout the universe are related to the underlying physical laws and properties of matter.
- Exploring the nature of light and how our understanding of the interactions of light and matter play such an important part in advancing our knowledge.
- Elucidating how we have been able to develop knowledge of the history and timescales of cosmic processes and events that produced -- and continue to sustain -- our surroundings.
- Exercising skill in the rudimentary application of basic mathematics (arithmetic) to understanding our world and phenomena around us.
- Developing an appreciation for the contingency and moving boundaries of knowledge, helping to perspective about the difference between what we know with high certitude, and what we do not know, and why.

Class Website

Certain course materials including homework assignments will be distributed and collected through the Rice CANVAS webpage for this course, ASTR 202 F18 [https://canvas.rice.edu/courses/14089], You are responsible for reading emails from the

class website and checking the CANVAS course website regularly for up-to-date posted information and assignments. Other materials will be posted at a separate website linkable from the CANVAS course site.

Course Textbook

The textbook for the course is:

> ***THE COSMIC PERSPECTIVE*** (8th or 7th edition)
> by Bennett, Donahue, Schneider and Voit; Pearson (Addison-Wesley)

Generally speaking, the scope of this course pertains to Chapters 1-14 of the above book.

The above, full, version of the textbook also covers the material for ASTR-201 (Stars, Galaxies and the Universe). If you buy the book new and want the most up-to-date version, get the 8th edition. However, you will not be disadvantaged in this class by using the 7th (or even the 6th) edition, which you may be able to obtain at a lower price.

Another, reduced, version of the textbook (THE COSMIC PERSPECTIVE - SOLAR SYSTEM) is available at a somewhat lower -- though at a cost significantly greater than half of the full book. If you are certain that you will not be take ASTR-201 (*Stars, Galaxies and the Universe*), a companion to this course, you may consider purchasing the reduced version.

Homework &Tests

Homework: Approximately weekly homework assignments based on material covered during the previous week (or weeks) in class lectures or in the textbook. Homework assignments will be posted on CANVAS and will normally be due a week later. For the homework, you may consult the textbook, your notes, and other materials, including the Web, unless otherwise indicated in writing. You may (and are encouraged to) discuss concepts and approaches with your classmates before answering the questions, but the answers and work you submit must be entirely your own. Occasionally, for a homework question/problem, you may need to seek factual information available from the Web.

Occasional Pop Quizzes: Throughout the semester, there may be occasional, unannounced short pop quizzes administered in class. These short quizzes are likely to make use of Web-based electronic response. For those who do not bring a usable web-response device to class, provision will be made for paper response.

Tests: There will be two tests, one midterm test during the first half of October, and one end-term test during the last week of class; the end-term test will encompass class material from the second half of the semester, covered since the first test. For tests you may consult both the textbook and your own class notes. However, no other materials or sources, including web browsing, are permitted for tests: Each student is to complete the tests on her or his own, with no consultation. The tests will be similar to the homework in nature, but are to be pledged under the Honor Code as solely your work.

There will be no separate final exam.

Grades

Course grades will be based on the homework, the mid-term & end-term tests.

40% Homework
10% Pop Quizzes
50% Tests (25% each for mid-term & end-term)

The final grading scale may be adjusted on the basis of outcomes rather than based on a rigid, predefined rubric. Every student who regularly and attentively attends class, and who diligently and attentively carries out the reading, study and homework assignments, should be able to achieve a fine grade in this class.

In computing final grades, each student's lowest two homework scores will automatically be dropped, and the same for each student's lowest two pop quiz scores.

Special Needs

Any student with a documented disability needing academic adjustments or accommodations should speak with the instructor during the first two weeks of class. All such discussions will be held confidential. Students with disabilities will need to contact Disability Support Services in the Ley Student Center: http://dss.rice.edu.

Adherence to Honor Code

The Rice Honor Code applies to all assignments in this class. All students should be familiar with Honor Code and Council rules and procedures, which can be found at http://honor.rice.edu. Be aware that, under Rice rules, the instructor has little discretion in reporting suspected violations, and is required to report such suspicions to the Honor Council for independent disposition.

Observing Sessions

The Rice University Campus Observatory (RUCO: www.ruf.rice.edu/~ruco/observatory.html) provides opportunity for hands-on observation of Solar System and other astronomical objects. Observing sessions will be scheduled during the semester. Earth-based astronomical observing is subject to weather and local 'seeing' conditions. Observing sessions may be organized and cancelled at unavoidably short notice. The best nights for practical astronomy are clear and cold, so you may want to dress warmly. You may want to take advantage of these optional -- but interesting -- experiences.

Issues Arising

If you encounter concerns, experiences, difficulties, or misunderstandings that affect you in this class, you should speak directly with the professor as soon as you can.

Syllabus Subject to Possible Change

The information in this syllabus is subject to possible revision during the semester. If any changes are made, enrolled students will be notified in a timely manner.